

## **Ceteacean Social Behavioral Response to Sonar**

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### **LONG-TERM GOALS**

The goal of this effort is to investigate cetacean social behavioral response to sonar signals.

### **OBJECTIVES**

The scientific objectives of this effort are 1) to study social, group-level behavioral responses of cetaceans to sonar signals and other stimuli, including tagging; 2) to study natural, baseline social behavior of the cetaceans studied; 3) to develop quantitative, generic methods and protocols for the study of social, group-level behavior of cetaceans; 4) to develop methods to study behavioral responses of cetaceans to sonar signals in situations where tagging is not at present possible (tagless playbacks); 5) to facilitate in the integration of methods and data from different behavioral response studies.

### **APPROACH**

Social, group-level cetacean behavioral responses to sonar signals and other stimuli (tagging effort, killer whale playbacks) as well as baseline behavior, are studied within the larger framework of controlled exposure experiments (CEEs) conducted as part of the 3S/3S<sup>2</sup> behavioral response studies (BRS) off Norway. Visual collection of cetacean social behavioral parameters takes place simultaneous with focal individual tracking and data-collection from suction-cup tags and towed hydrophone arrays. Additional baseline behavior of the studied cetaceans is obtained during dedicated baseline behavior research at the Azores (land- and vessel-based), to allow for increased sample size and augmented understanding of natural behavior of the cetaceans studied, in relation to observed behavioral responses to stimuli.

Focal follow sampling protocols for visual sampling of cetacean group behavior were developed specifically for the use in this project. Specific requirements for the protocols included non-biased, quantitative, systematic and generic collection of cetacean group behavior, providing high quality data allowing for comparison across species, studies and areas. Generic properties of sampling protocols facilitating cross-comparison of data are deemed to be of special importance in BRS studies, often characterized by relatively limited sample sizes.

In cooperation with the Social-BRS project, the performance of group-level focal follow protocols for use in tagless playbacks is tested during dedicated research off California. In addition, cooperation is established to further incorporate sampling of social behavior of cetaceans in CEEs in BRS.

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Data analysis specifically focuses on the integration between surface social behavior recorded by focal follows and group vocal behavior recorded by the suction-cup tags and towed hydrophone arrays, focal individual tracking and dive characteristics recorded by the suction-cup tags.

#### *Key individuals*

Patrick Miller (SMRU, Scotland), Peter Tyack (WHOI, USA and SMRU, Scotland), Frans-Peter Lam (TNO, the Netherlands) and Petter Kvadsheim (FFI, Norway) form the board of the 3S-project. Together with Hans Slabbekoorn, assistant professor at the Behavioural Biology Group of Leiden University, the Netherlands, they act as main scientific advisors in this project. Brandon Southall (SEA.inc), PI of the Socal-BRS project, has a main role in the design and execution of tagless playbacks and cross-study implementation of group sampling methods in BRS.

### **WORK COMPLETED**

- Development of protocol for group behavior sampling of cetaceans
  - Status: operational (Visser et al. 2011)
- Field-work
  - Participation in 3S<sup>2</sup> and Socal-BRS field studies
  - Lead Azores-Baseline pilot field study
  - Field study and data-collection ongoing: year one of three
- Social behavioral response data-collection in behavioral response studies (year 1)
  - Tagging, sonar exposure and killer whale playback stimuli in 3S<sup>2</sup>
- Baseline social behavioral data-collection (year 1)
  - 3S<sup>2</sup>, Azores-Baseline and Socal-BRS field studies
- Development and testing of protocols for tagless playbacks
  - Status: development, testing and evaluation in Socal-BRS
  - Target species: pelagic *Delphinids*
- Cross-study implementation of group sampling methodology
  - Protocols used in 4 BRS studies in 2011: 3S<sup>2</sup>, Socal-BRS, Azores-Baseline and BRS-Med.
- Presentation of 3S social behavior results at ESOMM Conference, the Netherlands

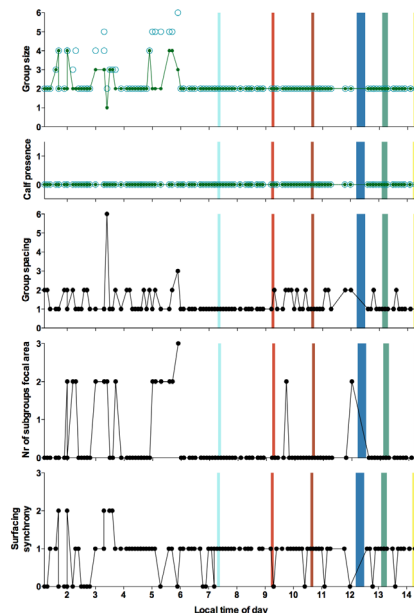
### **RESULTS**

- *Operational protocol for group sampling of cetaceans*

In 2011, the group sampling protocol developed in 3S was tested on a selection of new species, in new areas and by several different projects. It was found that the protocol is widely applicable to cetacean species forming relatively stable, small-medium sized groups (<30), and can be applied to new conditions without significant changes to the set-up. The project has resulted in an operational generic and quantitative group sampling protocol, enabling the comparison of data across (BRS) studies. Additional added value of the protocol was found in the recording of surface behaviors for species which typically spend longer times at or near the surface, including when foraging, potentially limiting the capability of the tag to differentiate between behavioral states. The protocol will be published as part of the 3S-2011 cruise report (open-access) (Visser et al. 2011).
- *Data-collection: social behavioral response and natural behavior*

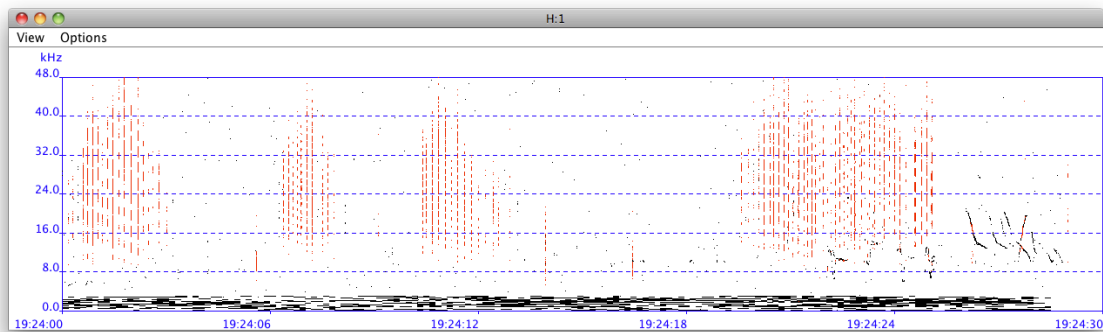
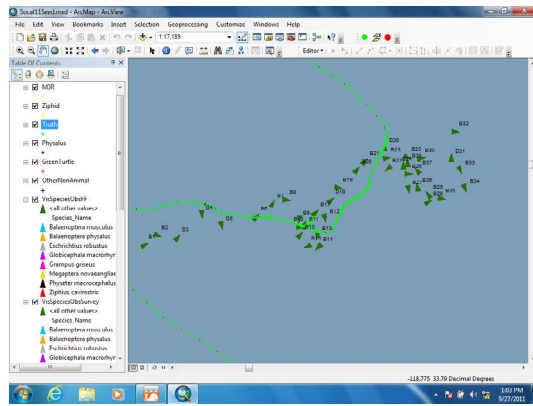
Group and surface behavior data of humpback whales and minke whales was recorded during 5 and 1 CEEs respectively (including tagging, baseline, sonar exposure and killer whale playback

periods) using the group sampling protocols (Fig. 1). Baseline data outside of CEEs was collected for Northern bottlenose whales, Risso's dolphins and short-finned pilot whales. Data-collection currently is an ongoing process for all species sampled, and will be continued during fieldwork efforts in 2012 and 2013.



**Figure 1. Example of humpback whale group behavior sampling data collected June 9, 2011 during the 3S<sup>2</sup> research cruise off Spitsbergen. The experiment time-line consecutively shows baseline (white), exposure (silent ramp-up, ramp-up I, ramp-up II, killer whale playbacks and noise (blue, red and blue-green bars)) and biopsy sampling (yellow bar) periods. Not shown: pre-, during and post-tagging data.**

- *Development and testing of tagless playback protocols*  
Tagless playback protocols were designed specifically for species for which it is currently not possible to deploy a tag for longer durations, but which generally occur in high densities (high probability of being exposed to sonar): pelagic *Delphinids* such as common and bottlenose dolphins. The size and fluid nature of groups of these species require a different protocol than is used for the previously studied species. The structural difference is that it is not possible to select a focal individual and its associated focal (sub)group for the duration of the follow; the entire group needs to be included in sampling. In addition, the set-up of the Socal-BRS project required the tagless playbacks to take place from a stationary observation platform. Newly developed protocols were tested during the Socal-11 trial. Three pilot baseline tagless playbacks were executed (2 for longbeaked common dolphins, 1 for bottlenose dolphin). For one out of the three follows, tracking and behavior recording was well-established and conditions would have been suitable for a tagless playback (Fig. 2). Main limiting conditions for tagless focal follows were sea state >Bft 2, swell >1-2 m and high group spread. In addition, strong variation in directionality and speed can result in limited tracking capability.



**Figure 2.** *Top left: Screenshot from WildMapper showing the trackline of the successful focal follow of longbeaked common dolphins. Numbered green triangles indicate consecutive locations along the dolphins' track. Dotted green line represents the track of the research vessel. Top right: 4 dedicated observers conducting the focal follow observation (Photographer: K. Laveck, Cascadia Research). Bottom: Click trains and whistles of the longbeaked common dolphin group during the focal follow, recorded by a sono buoy.*

Current evaluation of the methods and results from Socal-11 is aimed to result in an operational protocol in the testing phase for Socal-12, applicable to a wide range of species. A main result from the evaluation on-site was the added value of incorporating acoustic data from sono buoys or hydrophones. Raw field analysis indicated alterations in vocalization patterns (clicks-trains and whistles) simultaneous with observed changes in behavioral states (Fig. 2).

- *Cooperation with different BRS research projects*

It was considered highly valuable to exchange methods and knowledge between BRS research projects in the field, which strongly facilitated the implementation and exchange of different methods both ways, and potentially future cooperation in data analysis. The use of the operational protocols in 4 different BRS projects facilitates future cross-comparison and potential joint analysis of BRS data.

## IMPACT/APPLICATIONS

The generic nature of the methods and protocols developed in this effort can facilitate future cross-comparison of data between BRS projects, species and areas. It also may serve as a tool to extend BRS methodology to include species for which tagging methodology currently is not available.

## RELATED PROJECTS

*3S Project.* A large part of the fieldwork for this work is and has been executed as an integral part of the 3S project, in close cooperation with the 3S research team. Group sampling methodology for BRS as described here was developed within the 3S project and is now continuing in its follow-up project, 3S<sup>2</sup>.

*Socal-BRS.* Cooperation in the development and execution of tagless playbacks and group sampling methodology in BRS. Socal-11 project website: <http://sea-inc.net/socal-brs/socal-11/>

## REFERENCES

*Visser et al. (2011). Group behaviour sampling protocol for behavioural response studies. In: Kvadsheim et al. (2011). Behavioural response studies of cetaceans to naval sonar signals in Norwegian waters - 3S-2011 Cruise Report. FFI-rapport 2011/01289*

## PUBLICATIONS

*Visser et al. (2011). Group behaviour sampling protocol for behavioural response studies. In: Kvadsheim et al. (2011). Behavioural response studies of cetaceans to naval sonar signals in Norwegian waters - 3S-2011 Cruise Report. FFI-rapport 2011/01289*